High-temperature MBE of hBN for Deep-ultraviolet, Single-photon Emitters and Lateral Heterostructures

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There has been a surge of interest in hexagonal boron nitride (hBN) due to its technological potential for deep ultraviolet (DUV) photonics, single photon emitters (SPEs) and through its incorporation into van der Waals (vdW) two-dimensional (2D) heterostructures.

We have developed high-temperature molecular beam epitaxy (HT-MBE) of hBN at growth temperatures from 1100ºC to 1700ºC using high-temperature sublimation and e-beam MBE sources for boron and nitrogen RF-plasma sources. We will discuss our measurements of a direct optical energy gap of ~6.1 eV and electronic band gap of ~6.8 eV in single monolayer hBN. We will demonstrate that the single-photon emitters can be reproducible produced in hBN layers by C-doping.

Boron has two naturally occurring stable isotopes and the natural mixture contains ^{11}B (80.1%) and ^{10}B (19.9%). We will explore HT-MBE of h-BN using isotopically enriched (>98%) boron ^{10}B and ^{11}B with 6N purity.

Recent studies worldwide have focused on the development of novel 2D lateral heterostructures with unique transport and optical properties. Whereas vertical 2D heterostructures can be produced by epitaxy or by exfoliating and stacking of 2D layers, lateral 2D heterostructures can only feasibly be produced by an epitaxial growth process. Sequential HT-MBE growth of hBN, graphene and a second cycle of hBN growth resulted in the formation of lateral hBN–graphene–hBN heterostructures, in which a strip of graphene is laterally embedded between monolayers of hBN.

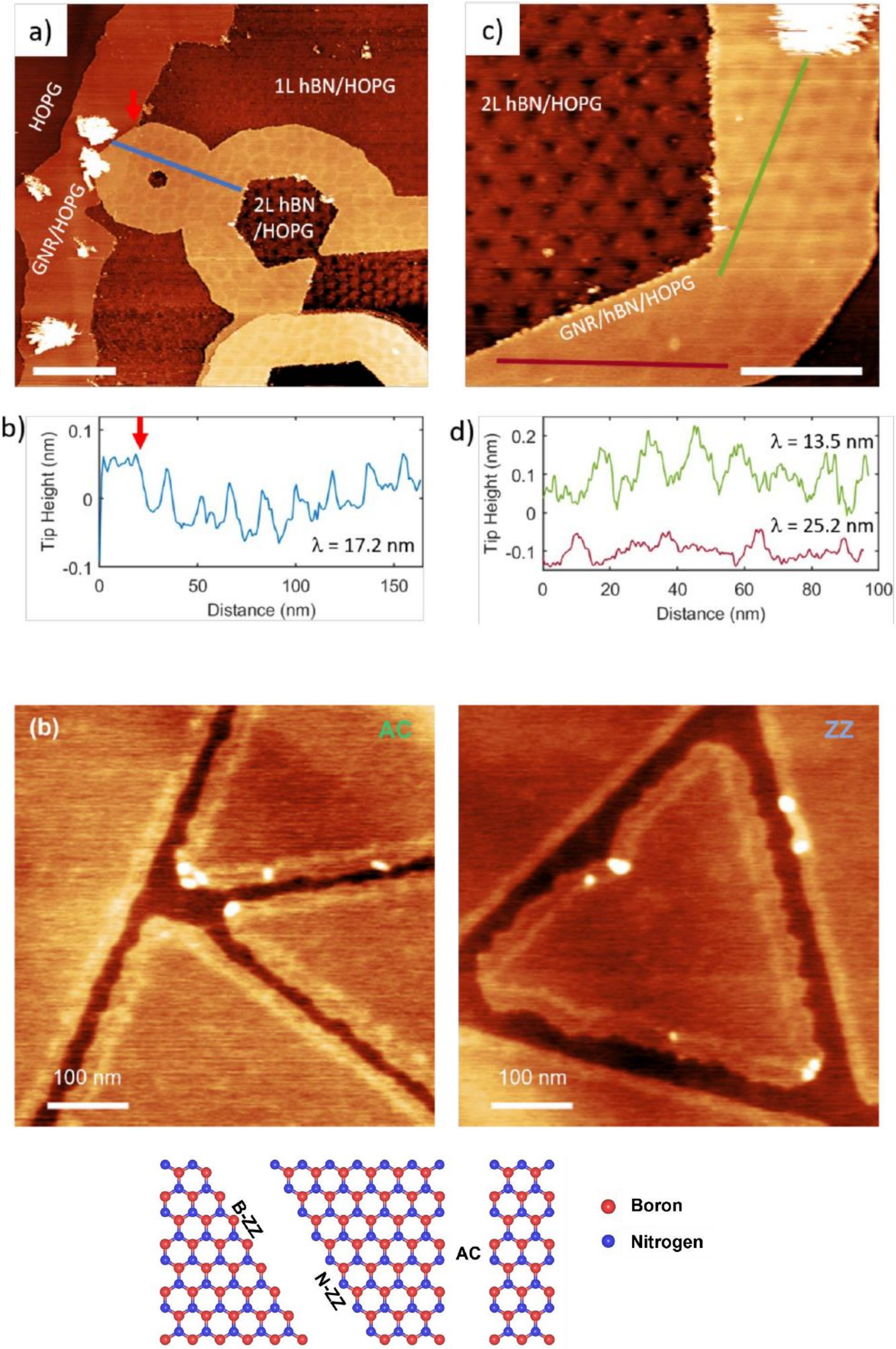

Fig. 1. Graphene (G) - Boron Nitride (hBN) lateral heterostructures.